PATENT ABSTRACTS OF JAPAN

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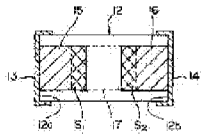
(21)Application number : 04-041338 (71)Applicant : MURATA MFG CO LTD

(22)Date of filing : 27.02.1992 (72)Inventor : KAWASE MASAHIKO

(54) LAMINATED THERMISTOR



(57)Abstract:

PURPOSE: To obtain structure, in which an effective overlapping area between internal electrodes is difficult to be varied, by composing one of the internal electrodes of first and second isolation electrodes and the other of non-connection type internal electrodes.

CONSTITUTION: First and second isolation electrodes 15, 16 extended from end faces 12a, 12b to the central side so as to be electrically connected to external electrodes 13, 14 are formed into a sintered body 12. A non-connection type internal electrode 17 is formed separated from the first and second isolation electrodes 15, 16 and ceramic layers 12c. The non-connection type internal

electrode 17 is constituted in a rectangular shape, and arranged so as to be superposed to both the first and second isolation electrodes 15, 16. Accordingly, even when the positions of the formation of the first and second isolation electrodes and the non-connection type internal electrode are displaced slightly, the varying section of the overlapping areas of the internal electrode is offset mutually, and dispersion can be reduced extremely, thus inhibiting a resistance value at a small value.

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[Date of extinction of right]	

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CLAIMS

[Claim(s)]

[Claim 1] Overlap on both sides of the ceramic layer which functions as the sintered compact which has the ceramic layer which functions as a thermistor as said thermistor, and even if few, it has the internal electrode of a pair. One side of the internal electrode of said pair consists of the 1st and 2nd division electrode extended by the central site from the both-ends side of said sintered compact. The laminating thermistor which another side consists of a connectionless mold internal electrode arranged so that the said 1st and 2nd division electrode may be overlapped, is formed in the both-ends side of said sintered compact, and is characterized by having further the external electrode of a pair electrically connected with the predetermined internal electrode.

[Claim 2] The laminating thermistor according to claim 1 carried out if the width of face of the said 1st and 2nd division electrode is the width of face and ** of said connectionless mold internal electrode.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] Especially this invention relates to the laminating thermistor which has the structure which raised the precision of the overlap area between internal electrodes by improving internal electrode structure about a laminating thermistor.

[0002]

[Description of the Prior Art] Drawing 2 is the sectional view showing an example of a well-known laminating thermistor. The laminating thermistor 1 has the structure which formed internal electrodes 3 and 4 so that it might overlap through ceramic layer 2a in the sintered compact 2 which consists of semi-conductor porcelain which functions as a thermistor. Internal electrodes 3 and 4 are pulled out by end-face 2b of a sintered compact 2, and one side of 2c, and are electrically connected to end-face 2b and the external electrodes 5 and 6 formed so that 2c might be covered, respectively.

[0003] With the laminating thermistor 1, the thermistor of low resistance which was not obtained can be offered with the thermistor component of the conventional veneer mold changing the thickness of ceramic layer 2a, or by changing the overlap area of internal electrodes 3 and 4.

[0004]

[Problem(s) to be Solved by the Invention] However, in the above-mentioned laminating thermistor 1, since the overlap area of internal electrodes 3 and 4 influenced resistance greatly, there was a problem of being easy to produce

dispersion in resistance by the lap gap between the internal electrode 3 in a manufacture phase and 4 etc. This is explained with reference to drawing 3 and drawing 4 . When internal electrodes (die-length L1 =1.6mm and width-of-face W1 =0.8mm) 3 and 4 are correctly formed in the sintered compact 2 with a die length [of L= 2mm], and a width of face of W= 1.2mm as shown in drawing 3 (a) and (b) for example, both effective lap area is 0.8mmx1.2mm=0.96mm2. It becomes. However, as shown in drawing 4 (a) and (b), when one internal electrode 4 shifts X= 0.1mm and is formed in an end-face 2b side, an internal electrode 3 and the effective lap area between four become small by field 4a (field of the area of 0.1mmx0.8mm=0.08mm2). That is, resistance changes no less than 8.3% only by the formation location of an internal electrode 4 shifting 0.1mm.

[0005] Then, it is necessary to form the above-mentioned internal electrodes 3 and 4 so that it may overlap correctly in a sintered compact 2. On the other hand, after printing conductive paste to a ceramic green sheet, internal electrodes 3 and 4 carry out a laminating with the ceramic green sheet of two or more sheets, and, finally are completed by the ceramics and really calcinating. It was very difficult to lose completely the gap at the time of printing of the above-mentioned conductive paste, and the laminating of a ceramic green sheet, therefore it very difficult to prevent fluctuation of an internal electrode 3 and the effective lap area between four in the laminating thermistor 1.

[0006] The purpose of this invention is to offer the laminating thermistor equipped with the structure which fluctuation of the effective lap area between internal electrodes cannot produce easily.

[0007]

[Means for Solving the Problem] The sintered compact which has the ceramic layer on which the 1st invention of this application functions as a thermistor, Overlap on both sides of the ceramic layer which functions as said thermistor, and even if few, it has the internal electrode of a pair. One side of the internal electrode of said pair consists of the 1st and 2nd division electrode extended by

the central site from the opposite end face of said sintered compact. It is the laminating thermistor which another side consists of a connectionless mold internal electrode arranged so that the said 1st and 2nd division electrode may be overlapped, and is formed in the both-ends side of said sintered compact, and is characterized by having the external electrode of a pair electrically connected with the predetermined internal electrode. Moreover, it is the laminating thermistor characterized by carrying out the 2nd invention of this application if the width of face of the said 1st and 2nd division electrode is the width of face and ** of said connectionless mold internal electrode.

[0008]

[Function] One side is constituted among the internal electrodes of a pair at least by the 1st and 2nd overlapping division electrode which was extended by the central site from the opposite end face of a sintered compact. Since it is arranged so that another side may consist of a connectionless mold internal electrode and a connectionless mold internal electrode may overlap the 1st and 2nd division electrode, Even if the formation location of the 1st and 2nd division electrode and a connectionless mold internal electrode shifts a little Since a fluctuated part of the lap area of one division electrode and a connectionless mold internal electrode will be offset by fluctuated part of the lap area of the division electrode of another side, and a connectionless mold internal electrode, fluctuation of an internal inter-electrode effective lap area can be prevented.

[0009] Moreover, since it is carried out in the 2nd invention of this application if the width of face of the 1st and 2nd division electrode and the width of face of a connectionless mold internal electrode are **, Even if the formation location of the 1st and 2nd division electrode and a connectionless mold internal electrode shifts a little crosswise, as long as either the 1st and 2nd division electrode or a connectionless mold internal electrode is located in the width of face of another side, the effective lap area between the 1st and 2nd division electrode and the internal electrode of a connectionless mold is not changed.

[0010]

<DP N=0003> [Example]

The 1st example drawing 5 is the perspective view showing the laminating thermistor concerning the 1st example of this invention. The laminating thermistor 11 has the structure which formed the external electrodes 13 and 14 so that the both-ends side of the rectangular parallelepiped-like sintered compact 12 might be covered. The sintered compact 12 is constituted by the ceramic ingredient which can demonstrate the negative characteristic as a thermistor like for example, manganese-nickel system semi-conductor porcelain. As shown to drawing 6 in drawing of longitudinal section, in the sintered compact 12, the 1st and 2nd division electrode 15 and 16 extended by the central site from end faces 12a and 12b is formed so that it may connect with the external electrodes 13 and 14 electrically. The 1st and 2nd division electrode 15 and 16 is constituted so that it may have a rectangle configuration with a flat-surface sectional view, as shown in drawing 1 .

[0011] The return, 1st, and 2nd division electrode 15 and 16 and ceramic layer 12c are separated to drawing 6 , and the connectionless mold internal electrode 17 is formed in it. The connectionless mold internal electrode 17 is constituted so that it may have a rectangular configuration in drawing 1 , as a broken line shows, and it is arranged so that the both sides of the 1st and 2nd division electrode 15 and 16 may be overlapped. Through ceramic layer 12a, while overlap and the internal electrode is constituted from the above-mentioned laminating thermistor 11 by the 1st and 2nd division electrode 15 and 16. Therefore, it is the field S1 which the lap area of the 1st and 2nd division electrode 15 and 16 and the connectionless mold internal electrode 17 attaches hatching which the slash intersects as shown in drawing 1 , and shows. And field S2 It becomes the sum total.

[0012] For the distance between both, as that to which it does not change, the now, 1st, and 2nd formation location of the division electrodes 15 and 16 is one lap field S1, when it hits on an idea of the case where it shifts in the direction to which end faces 12a and 12b are connected. It is S1 when it becomes small.

Only a decrement is the lap field S2 of another side. Area increases. It also sets, when similarly the formation location of the connectionless mold internal electrode 17 shifts in the direction to which end faces 12a and 12b are connected, and it is the lap field S1. A fluctuated part and lap field S2 A fluctuated part will be offset. Therefore, in the laminating thermistor 11 of the 1st example, fluctuation of an internal inter-electrode lap area when the formation location of one internal electrode and the internal electrode of another side shifts towards connecting end faces 12a and 12b can be prevented certainly.

[0013] In addition, the laminating thermistor 11 can be manufactured from before using the manufacture approach of well-known laminating electronic parts. As shown in drawing 7 , for example, on rectangular ceramic green sheet 18a and 18b In order to form the 1st and 2nd division electrode 15 and 16 in the above-mentioned connectionless mold internal electrode 17 list, conductive paste is printed, respectively. The above-mentioned ceramic green sheets 18a and 18b, After carrying out the laminating of the ceramic green sheets 18c, 18d, 18e, and 18f of the up and down same number of sheets with a proper rectangle and being stuck in the thickness direction by pressure, the above-mentioned sintered compact 12 can be obtained by really calcinating. And the laminating thermistor 11 can be obtained by forming the external electrodes 13 and 14 of a pair according to the well-known external electrode formation approach.

[0014] Moreover, although the 1st and 2nd division electrode 15 and 16 and the connectionless mold internal electrode 17 lap through the ceramic layer 17 in the laminating thermistor 11 of the 1st example Also in the laminating thermistor 19 which carried out the laminating of two or more internal electrodes into the sintered compact 12, an internal electrode like [as shown in drawing 8 in schematic drawing / while] the above-mentioned example with the 1st and 2nd division electrode 15 and 16 By constituting the internal electrode of another side from a connectionless mold internal electrode 17, fluctuation of internal electrode lap area can be prevented like the above-mentioned example.

[0015] The 2nd example drawing 9 is the flat-surface sectional view showing the

laminating thermistor 20 concerning the 2nd example of this invention, and is drawing equivalent to drawing 1 which showed the 1st example. In the laminating thermistor 20, the 1st and 2nd division electrode 22 and 23 and the connectionless mold internal electrode 24 are arranged in the sintered compact 21. So far, it is the same as that of the 1st example. The width of face of the connectionless mold internal electrode 24 has the description of this example in being made narrower than the width of face of the 1st and 2nd division electrode 22 and 23. Therefore, even if the formation location of the formation location [of the connectionless mold internal electrode 24] or 1st, and 2nd division electrode 22 and 23 shifts crosswise [of a sintered compact 21] a little, as long as the connectionless mold internal electrode 24 is located in the width of face of the 1st and 2nd division electrode 22 and 23, fluctuation of electrode lap area is prevented.

[0016] That is, in the laminating thermistor 20 of the 2nd example, even when an electrode formation location shifts in the cross direction of not only the direction to which the both-ends sides 21a and 21b of a sintered compact 21 are connected but the sintered compact 21, fluctuation of electrode lap area may be prevented. In addition, conversely, although width of face of the connectionless mold internal electrode 24 was made narrower than the 1st and 2nd division electrode 22 and 23 in the laminating thermistor 20 of the 2nd example shown in drawing 9 , as shown in drawing 1010 , width of face of the 1st and 2nd division electrode 22 and 23 may be made thinner than the width of face of the connectionless mold internal electrode 24.

[0017] In the laminating thermistor of the 3rd example [1st and 2nd] of an example The 1st and 2nd division electrode 15, 16, 22, and 23 is formed so that it may extend in a central site from the both-ends sides 12b, 12c, 21a, and 21b of sintered compacts 12 and 21. And it is arranged so that the 1st and 2nd division electrode 15, 16, 22, and 23 may separate the gap of predetermined distance and may counter in a central part. However, as shown in drawing 11 (a), the thing of the structure which both tip separates predetermined distance and has

not countered in the sintered compact 25 as 1st and 2nd division electrode 27 and 28 which laps with the connectionless mold internal electrode 26 may be formed. Namely, although the division electrodes 27 and 28 are extended by the central site from end faces 25a and 25b Although the division electrode 27 and the division electrode 28 are put in order and formed in the cross direction of a sintered compact 25 and both tips 27a and 28a have not countered, it also sets in this structure. Since the connectionless mold internal electrode 26 laps with the both sides of the 1st and 2nd division electrode 27 and 28, even if a gap of the electrode formation location in the cross direction of a sintered compact 25 arises like the case of the 2nd example, fluctuation of electrode lap area can be prevented.

[0018] Similarly, as shown in drawing 11 (b), even if it is the case where the 1st and 2nd division electrode 27 and 28 is formed in a triangular configuration, fluctuation of electrode lap area can be prevented like the example shown in drawing 11 (a).

[0019] As it was below an example of an experiment, the laminating thermistor of elegance was produced this invention article 1-4 and conventionally, and resistance and its dispersion were evaluated.

This invention article 1 -- The ceramic green sheet with a die-length [of 2.4mm] x width-of-face [of 1.5mm] x thickness of 100 micrometers of two or more sheets was prepared. And as shown in drawing 12 (a), on the ceramic green sheet 30 of one sheet, conductive paste was printed in die length of 1.0mm, and magnitude with a width of face of 1.0mm, and the 1st and 2nd division electrode 31 and 32 was formed.

[0020] Similarly, on the ceramic green sheet 33 of one of the sheets prepared as mentioned above, as shown in drawing 12 (b), the connectionless mold internal electrode 34 with a width of face [of 1.0mm] and a die length of 2.0mm was formed in the center of the ceramic green sheet 33. And the laminating of the ceramic green sheets 30 and 33 was carried out, the laminating of the ceramic green sheet with which an electrode is not formed up and down was carried out,

and the Plastic solid with a thickness of 1.4mm was acquired. It is the acquired Plastic solid 2 t/cm2 After being stuck by pressure for 1 minute by the pressure, it calcinated at the temperature of 1200 degrees C for 2 hours, and the sintered compact was obtained. The laminating thermistor of this invention article 1 was produced by applying Ag paste to the both-ends side of the obtained sintered compact, and being burned on it for 10 minutes at the temperature of 800 degrees C.

[0021] This invention article 2 -- Using the ceramic green sheet 30 with which the 1st and 2nd division electrode 31 and 32 was printed like the case where this invention article 1 is obtained, as shown in drawing 13 , as shown in drawing 13 (b), conductive paste was printed to the down side to the field with a width of face [of 0.8mm], and a die length of 2.0mm, and the laminating of the ceramic green sheet 36 which comes to form the connectionless mold internal electrode 35 was carried out to it. And the laminating of the ceramic green sheet of proper number of sheets was carried out up and down, and the laminating thermistor of this invention article 2 as well as this invention article 1 was produced.

[0022] This invention article 3 -- As shown in drawing 14 (a), the 1st and 2nd division electrode 38 and 39 with a width of face [of 0.8mm] and a die length of 1.0mm was printed like the case where this invention article 1 is obtained, on one ceramic green sheet 37. To the inferior surface of tongue of the ceramic green sheet 37, the laminating of the ceramic green sheet 33 (what was shown in drawing 12 (b), and thing in which the electrode was formed similarly) shown in drawing 14 (b) was carried out, and the laminating thermistor of this invention article 3 was produced like the case where this invention article 1 is obtained, about other processes on it.

[0023] This invention article 4 -- The Plastic solid which carried out the 2-set laminating of the ceramic green sheets 30 and 36 (refer to drawing 13) used for obtaining this invention article 2, carried out the laminating of the ceramic green sheet of proper number of sheets up and down, and set the whole thickness to 1.4mm was acquired. About future processes, the laminating thermistor of this

invention article 4 was produced like the case where this invention article 1 is obtained.

[0024] The conventional article -- Conventionally, as elegance, as shown in drawing 15 (a), by applying conductive paste to the field of width of face of 1.0mm, and die-length 1.9mm magnitude, the laminating of the ceramic green sheets 42 and 43 with which electrodes 40 and 41 were formed was carried out, the laminating of the ceramic green sheet of proper number of sheets was carried out up and down, and the layered product with a thickness of 1.4mm was obtained. About future processes, the laminating thermistor of elegance was conventionally produced like the case where this invention article 1 is obtained. The resistance R25 and B constant in 25 degrees C per 20 laminating thermistors each of elegance were measured this invention article 1-4 produced as mentioned above and conventionally. A result is shown in the following table 1 with dispersion 3valve flow coefficient.

[0025]

[Table 1]

	R_{25} (Ω)	3CV (%)	B (K)	B3CV (%)
本発明品1	183	8.4	3053	0.20
本発明品2	260	5.0	3048	0.15
本発明品3	278	5.6	3062	0.18
本発明品4	91	6.0	3042	0.20
従来品	88	14.9	3031	0.21

[0026] In this invention article 1-4, dispersion in resistance is as small as 8.4% or less so that clearly from Table 1, and with elegance, it is dispersion R3valve flow coefficient of resistance conventionally to this. It turns out [14.9% and] that it is very large. In addition, although constituted from the example and the example of an experiment which have been mentioned above by the semi-conductor porcelain on which the whole sintered compact functions as a thermistor, in the

laminating thermistor of this invention, only the ceramic layer pinched with an electrode consists of ingredients which function as a thermistor, and should be clear and break. That is, about ceramic layers other than the ceramic layer pinched by inter-electrode, it may be constituted with the ceramic ingredient which does not function as a thermistor.

[0027] Moreover, although the manganese-nickel system semi-conductor porcelain which can demonstrate the negative characteristic was used as a ceramic ingredient, it cannot restrict to this and the ceramic ingredient which can demonstrate other negative characteristics can be used. Furthermore, the ingredient which can demonstrate a forward property as a thermistor like barium titanate system semi-conductor porcelain as a ceramic ingredient can also be used.

[0028]

[Effect of the Invention] In the 1st invention of this application, one side of an internal electrode is constituted by the 1st and 2nd division electrode, another side is constituted by the connectionless mold internal electrode, and since a connectionless mold internal electrode laps with the both sides of the 1st and 2nd division electrode, even if the formation location of the 1st and 2nd division electrode and/or the formation location of a connectionless mold internal electrode shift a little, an internal inter-electrode overlap area is uniformly maintainable.

[0029] Moreover, in the 2nd invention, even if the formation location of the 1st and 2nd division electrode and/or the formation location of a connectionless mold internal electrode shift in the cross direction of a sintered compact as long as the electrode of the narrower one is located in the internal electrode of the larger one since the width of face of the 1st and 2nd division electrode is carried out if it is the width of face and ** of a connectionless mold internal electrode, it becomes possible to keep an internal inter-electrode overlap area constant. Therefore, according to the 1st and 2nd invention of this application, since dispersion in the

lap area of an internal electrode can be made very small, it becomes possible to supply a laminating thermistor with little dispersion in resistance to stability.

[Translation done.]

* NOTICES *

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The flat-surface sectional view of the laminating thermistor of the 1st example.
[Drawing 2] Drawing of longitudinal section of the laminating thermistor of the conventional example.
[Drawing 3] (a) And (b) is each top view for explaining the internal electrode configuration of the conventional laminating thermistor, respectively.
[Drawing 4] (a) And (b) is each top view for explaining a trouble when a lap gap of the electrode in the conventional laminating thermistor arises.
[Drawing 5] The perspective view of the laminating thermistor of the 1st example.
[Drawing 6] Drawing of longitudinal section of the laminating thermistor of the 1st example.
[Drawing 7] The decomposition perspective view for explaining the process which obtains the laminating thermistor of the 1st example.

[Drawing 8] Drawing of longitudinal section for explaining the modification of the 1st example.
[Drawing 9] The flat-surface sectional view of the laminating thermistor of the 2nd example.
[Drawing 10] The flat-surface sectional view for explaining the modification of the 2nd example.
[Drawing 11] For (a), the flat-surface sectional view of the laminating thermistor concerning the 3rd example and (b) are a flat-surface sectional view for explaining the modification of the 3rd example.
[Drawing 12] (a) And (b) is each top view for explaining the electrode configuration in this invention article 1.
[Drawing 13] (a) And (b) is each top view for explaining the electrode configuration used for obtaining this invention article 2.
[Drawing 14] (a) And (b) is each top view for explaining the electrode configuration used for obtaining this invention article 3.
[Drawing 15] (a) And (b) is each top view for explaining the electrode configuration used for obtaining elegance conventionally.
[Description of Notations]
11 -- Laminating thermistor
12 -- Sintered compact
13 14 -- External electrode
15 16 -- The 1st, 2nd division electrode
17 -- Connectionless mold internal electrode
12a, 12b -- End face

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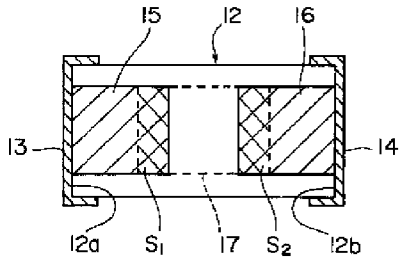
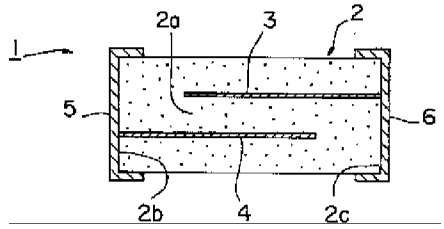
DRAWINGS

[Drawing 1]



[Drawing 2]



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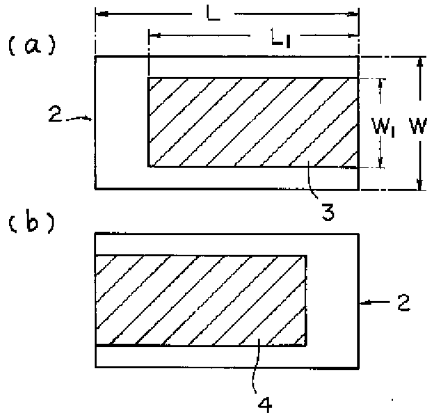

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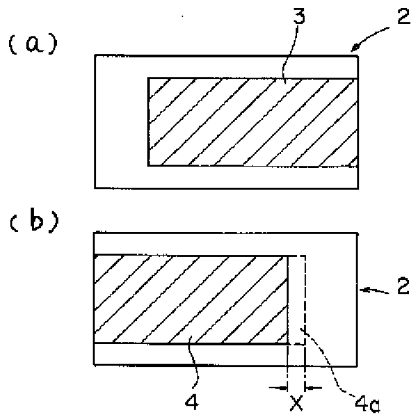

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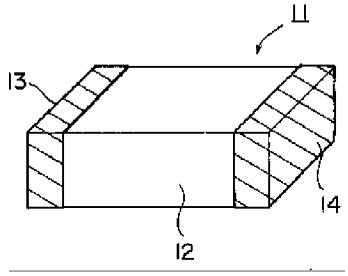

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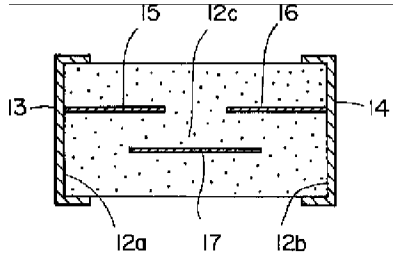
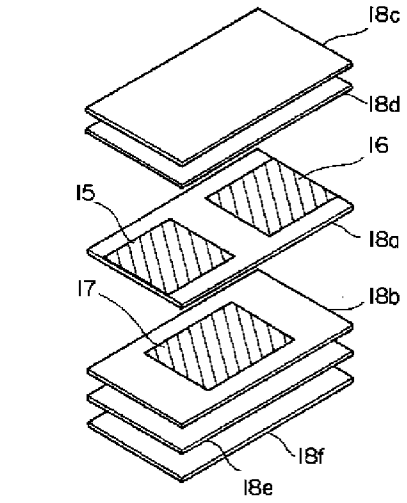


[Drawing 7]



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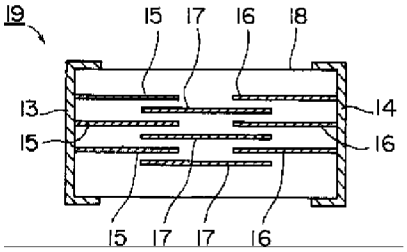
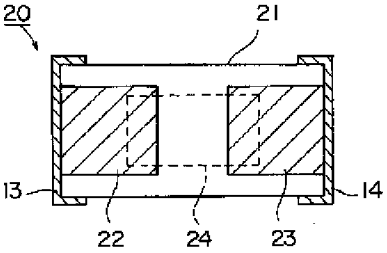
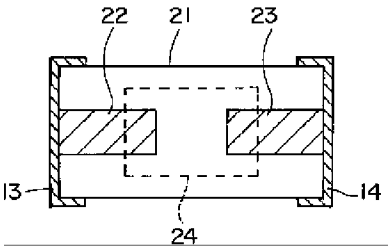


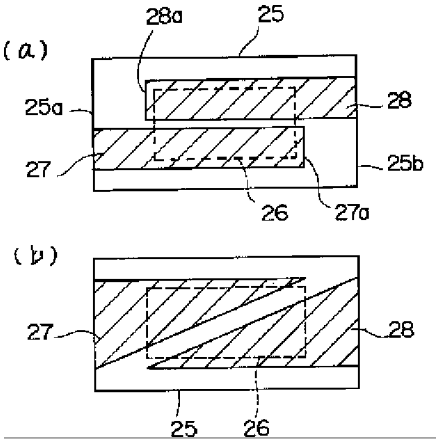
[Drawing 9]



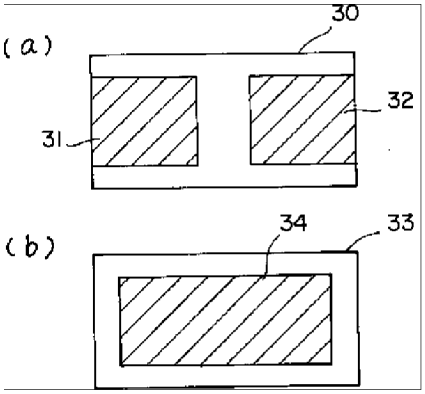
[Drawing 10]



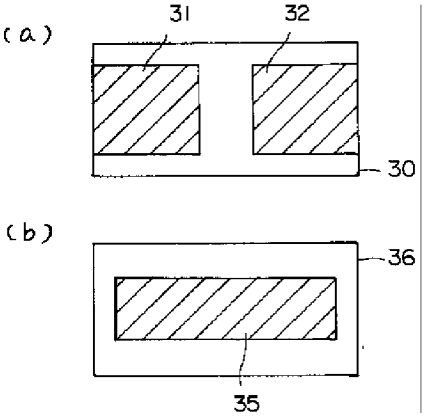
[Drawing 11]



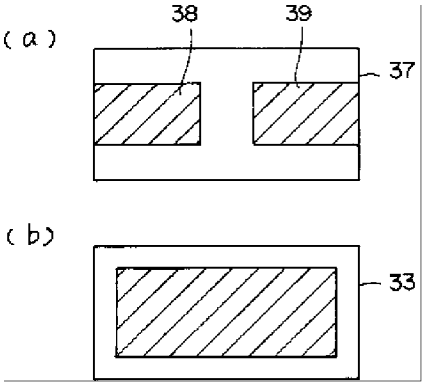
[Drawing 12]



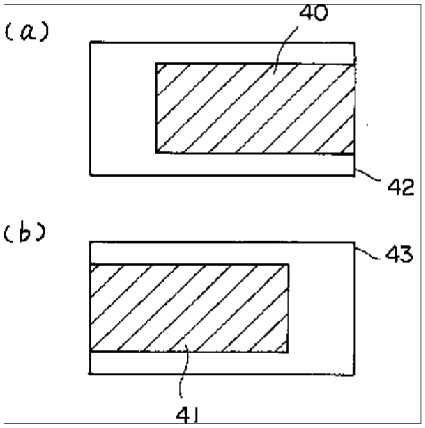
[Drawing 13]



[Drawing 14]



[Drawing 15]



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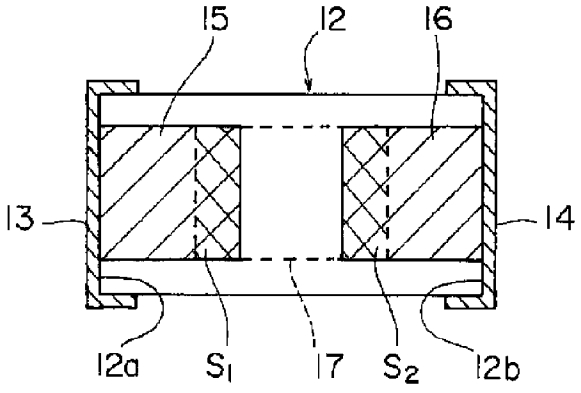
(71)出願人　000006231
株式会社村田製作所
京都府長岡京市天神二丁目26番10号
(72)発明者　川瀬　政彦
京都府長岡京市天神二丁目26番10号　株式会社村田製作所内
(74)代理人　弁理士　宮▼崎▲　主税

(54)【発明の名称】　積層サーミスタ

(57)【要約】　(修正有)
【目的】　内部電極の重なり面積の変動が生じ難い構造を備えた積層サーミスタを得る。
【構成】　セラミック層を介して重なり合うように第１，第２の分割電極１５，１６からなる一方の内部電極と非接続型内部電極１７よりなる他方の内部電極とを焼結体１２内に配置したことを特徴とする積層サーミスタ。



1

【特許請求の範囲】

【請求項1】サーミスタとして機能するセラミック層を有する焼結体と、

前記サーミスタとして機能するセラミック層を挟んで重なり合う少なくとも一対の内部電極とを備え、

前記一対の内部電極の一方が、前記焼結体の両端面から中央側に延ばされた第1，第2の分割電極からなり、他方が、前記第1，第2の分割電極と重なり合うように配置された非接続型内部電極からなり、

前記焼結体の両端面に形成されており、所定の内部電極と電気的に接続された一対の外部電極をさらに備えることを特徴とする、積層サーミスタ。

【請求項2】　前記第1，第2の分割電極の幅が、前記非接続型内部電極の幅と異ならされている、請求項1に記載の積層サーミスタ。

【発明の詳細な説明】

【0001】

【産業上の利用分野】本発明は、積層サーミスタに関し、特に、内部電極構造を改良することにより内部電極間の重なり合い面積の精度を高めた構造を有する積層サーミスタに関する。

【0002】

【従来の技術】図2は、公知の積層サーミスタの一例を示す断面図である。積層サーミスタ1は、サーミスタとして機能する半導体磁器よりなる焼結体2内にセラミック層2aを介して重なり合うように内部電極3，4を形成した構造を有する。内部電極3，4は、それぞれ、焼結体2の端面2b，2cの一方に引き出されており、端面2b，2cを覆うように形成された外部電極5，6に電気的に接続されている。

【0003】積層サーミスタ1では、セラミック層2aの厚みを変化させることにより、あるいは内部電極3，4の重なり合い面積を変化させることにより、従来の単板型のサーミスタ素子では得られなかった低抵抗のサーミスタを提供することができる。

【0004】

【発明が解決しようとする課題】しかしながら、上記積層サーミスタ1では、内部電極3，4の重なり合い面積が抵抗値に大きく影響するため、製造段階における内部電極3，4間の重なりずれ等により抵抗値のばらつきが生じやすいという問題があった。これを、図3及び図4を参照して説明する。図3（a）及び（b）に示すように、例えば長さL＝2mm及び幅W＝1．2mmの焼結体2内において、長さL_1＝1．6mm及び幅W_1＝0．8mmの内部電極3，4が正確に形成されている場合、両者の有効重なり面積は、0．8mm×1．2mm＝0．96mm^2 となる。ところが、図4（a），（b）に示すように、一方の内部電極4が端面2b側にX＝0．1mmずれて形成された場合、領域4a（0．1mm×0．8mm＝0．08mm^2 の面積の領域）分

2

だけ、内部電極3，4間の有効重なり面積が小さくなる。すなわち、内部電極4の形成位置が0．1mmずれただけで、抵抗値が8．3％も変化する。

【0005】そこで、上記内部電極3，4を焼結体2内において正確に重なり合うように形成する必要がある。他方、内部電極3，4は、セラミックグリーンシートに導電ペーストを印刷した後、複数枚のセラミックグリーンシートと共に積層し、セラミックスと一体焼成することにより最終的に完成されるものである。上記導電ペーストの印刷時やセラミックグリーンシートの積層時のずれを完全に無くすことは非常に難しく、従って、積層サーミスタ1では、内部電極3，4間の有効重なり面積の変動を防止することは非常に困難であった。

【0006】本発明の目的は、内部電極間の有効重なり面積の変動が生じ難い構造を備えた積層サーミスタを提供することにある。

【0007】

【課題を解決するための手段】本願の第1発明は、サーミスタとして機能するセラミック層を有する焼結体と、前記サーミスタとして機能するセラミック層を挟んで重なり合う少なくとも一対の内部電極とを備え、前記一対の内部電極の一方が前記焼結体の対向端面から中央側に延ばされた第1，第2の分割電極からなり、他方が、前記第1，第2の分割電極と重なり合うように配置された非接続型内部電極からなり、前記焼結体の両端面に形成されており、かつ所定の内部電極と電気的に接続された一対の外部電極とを備えることを特徴とする、積層サーミスタである。また、本願の第2発明は、前記第1，第2の分割電極の幅が、前記非接続型内部電極の幅と異ならされていることを特徴とする積層サーミスタである。

【0008】

【作用】重なり合う少なくとも一対の内部電極のうち一方が焼結体の対向端面から中央側に延ばされた第1，第2の分割電極により構成されており、他方が非接続型内部電極からなり、非接続型内部電極が第1，第2の分割電極と重なり合うように配置されているため、第1，第2の分割電極及び非接続型内部電極の形成位置が若干ずれたとしても、一方の分割電極と非接続型内部電極との重なり面積の増減分が、他方の分割電極と非接続型内部電極の重なり面積の増減分で相殺されることになるため、内部電極間の有効重なり面積の変動を防止することができる。

【0009】また、本願の第2発明では、第1，第2の分割電極の幅と非接続型内部電極の幅とが異ならされているため、第1，第2の分割電極及び非接続型内部電極の形成位置が幅方向に若干ずれたとしても、第1，第2の分割電極または非接続型内部電極の一方が他方の幅内に位置している限り、第1，第2の分割電極と非接続型の内部電極との間の有効重なり面積が変動しない。

【0010】

3

【実施例の説明】

第１の実施例

図５は、本発明の第１の実施例にかかる積層サーミスタを示す斜視図である。積層サーミスタ１１は、直方体状の焼結体１２の両端面を覆うように外部電極１３，１４を形成した構造を有する。焼結体１２は、例えばマンガン－ニッケル系半導体磁器のようなサーミスタとして負特性を発揮し得るセラミック材料により構成されている。図６に縦断面図で示すように、焼結体１２内には、外部電極１３，１４と電気的に接続されるように、端面１２ａ，１２ｂから中央側に延ばされた第１，第２の分割電極１５，１６が形成されている。第１，第２の分割電極１５，１６は平面断面図で図１に示すように、矩形形状を有するように構成されている。

【００１１】図６に戻り、第１，第２の分割電極１５，１６とセラミック層１２ｃを隔てて非接続型内部電極１７が形成されている。非接続型内部電極１７は、図１に破線で示すように、矩形の形状を有するように構成されており、第１，第２の分割電極１５，１６の双方に重なり合うように配置されている。上記積層サーミスタ１１では、セラミック層１２ａを介して重なり合う一方の内部電極が、第１，第２の分割電極１５，１６で構成されている。従って、図１に示すように、第１，第２の分割電極１５，１６と、非接続型内部電極１７との重なり面積は、斜線が交差しているハッチングを付して示す領域S_1 及び領域S_2 の合計となる。

【００１２】いま、第１，第２の分割電極１５，１６の形成位置が両者の間の距離は変わらないものとして、端面１２ａ，１２ｂを結ぶ方向にずれた場合を想到すると、一方の重なり領域S_1 が小さくなった場合には、S_1 の減少分だけ、他方の重なり領域S_2 の面積が増大する。同様に、非接続型内部電極１７の形成位置が端面１２ａ，１２ｂを結ぶ方向にずれた場合においても、重なり領域S_1 の増減分と、重なり領域S_2 の増減分とが相殺されることになる。従って、第１の実施例の積層サーミスタ１１では、一方の内部電極と他方の内部電極の形成位置が端面１２ａ，１２ｂを結ぶ方向でずれた場合の内部電極間の重なり面積の変動を確実に防止することができる。

【００１３】なお、積層サーミスタ１１は、従来より周知の積層電子部品の製造方法を利用して製作することができる。例えば、図７に示すように、矩形のセラミックグリーンシート１８ａ，１８ｂ上に、それぞれ、上記非接続型内部電極１７並びに第１，第２の分割電極１５，１６を形成するために導電ペーストを印刷し、上記セラミックグリーンシート１８ａ，１８ｂと、その上下に同じく矩形の適宜の枚数のセラミックグリーンシート１８ｃ，１８ｄ，１８ｅ，１８ｆを積層し、厚み方向に圧着した後一体焼成することにより、上記焼結体１２を得ることができる。そして、公知の外部電極形成方法に従って一対の外部電極１３，１４を形成することにより、積層サーミスタ１１を得ることができる。

4

【００１４】また、第１の実施例の積層サーミスタ１１では、セラミック層１７を介して第１，第２の分割電極１５，１６と、非接続型内部電極１７とが重なり合わされていたが、図８に略図的に示すように、焼結体１２内に、複数の内部電極を積層した積層サーミスタ１９においても、上記実施例と同様に一方の内部電極を第１，第２の分割電極１５，１６で、他方の内部電極を非接続型内部電極１７で構成することにより、上記実施例と同様に内部電極重なり面積の変動を防止することができる。

【００１５】第２の実施例

図９は、本発明の第２の実施例にかかる積層サーミスタ２０を示す平面断面図であり、第１の実施例について示した図１に相当する図である。積層サーミスタ２０では、焼結体２１内において、第１，第２の分割電極２２，２３と、非接続型内部電極２４とが配置されている。ここまでは、第１の実施例と同様である。本実施例の特徴は、非接続型内部電極２４の幅が、第１，第２の分割電極２２，２３の幅よりも狭くされていることにある。従って、非接続型内部電極２４の形成位置、あるいは第１，第２の分割電極２２，２３の形成位置が焼結体２１の幅方向に若干ずれたとしても、非接続型内部電極２４が第１，第２の分割電極２２，２３の幅内に位置する限り、電極重なり面積の変動が防止される。

【００１６】すなわち、第２の実施例の積層サーミスタ２０では、焼結体２１の両端面２１ａ，２１ｂを結ぶ方向だけでなく、焼結体２１の幅方向において電極形成位置がずれた場合でも、電極重なり面積の変動が防止され得る。なお、図９に示した第２の実施例の積層サーミスタ２０では、非接続型内部電極２４の幅が第１，第２の分割電極２２，２３よりも狭くされていたが、逆に、図１０に示すように、第１，第２の分割電極２２，２３の幅を非接続型内部電極２４の幅よりも細くしてもよい。

【００１７】第３の実施例

第１，第２の実施例の積層サーミスタでは、第１，第２の分割電極１５，１６，２２，２３が、焼結体１２，２１の両端面１２ｂ，１２ｃ，２１ａ，２１ｂから中央側に延びるように形成されており、かつ第１，第２の分割電極１５，１６，２２，２３が中央部分で所定距離のギャップを隔てて対向するように配置されていた。しかしながら、図１１（ａ）に示すように、焼結体２５内において非接続型内部電極２６と重なり合わされる第１，第２の分割電極２７，２８として、両者の先端が所定距離を隔てて対向されていない構造のものを形成してもよい。すなわち、分割電極２７，２８は、端面２５ａ，２５ｂから中央側に延ばされているが、分割電極２７と分割電極２８は焼結体２５の幅方向において並べて形成されており、両者の先端２７ａ，２８ａは対向されていないが、この構造においても、非接続型内部電極２６が第

5

1，第2の分割電極27，28の双方に重なり合わされているため、第2の実施例の場合と同様に焼結体25の幅方向における電極形成位置のずれが生じたとしても電極重なり面積の変動を防止することができる。

【0018】同様に、図11（b）に示すように、第1，第2の分割電極27，28を三角形の形状に形成した場合であっても、図11（a）に示した実施例と同様に電極重なり面積の変動を防止することができる。

【0019】実験例

以下のようにして、本発明品1～4及び従来品の積層サーミスタを作製し、抵抗値及びそのばらつきを評価した。

本発明品1…長さ2．4mm×幅1．5mm×厚み100μmの複数枚のセラミックグリーンシートを用意した。そして、図12（a）に示すように、1枚のセラミックグリーンシート30上に、長さ1．0mm及び幅1．0mmの大きさに導電ペーストを印刷し、第1，第2の分割電極31，32を形成した。

【0020】同様に、上記のようにして用意した内の1枚のセラミックグリーンシート33上に、図12（b）に示すように、セラミックグリーンシート33の中央に幅1．0mm及び長さ2．0mmの非接続型内部電極34を形成した。そして、セラミックグリーンシート30，33を積層し、その上下に電極の形成されていないセラミックグリーンシートを積層し、厚み1．4mmの成形体を得た。得られた成形体を2t／cm² の圧力で1分間圧着した後、1200℃の温度で2時間焼成し、焼結体を得た。得られた焼結体の両端面に、Agペーストを塗布し、800℃の温度で10分間焼き付けることにより、本発明品1の積層サーミスタを作製した。

【0021】本発明品2…図13に示すように、本発明品1を得た場合と同様に第1，第2の分割電極31，32が印刷されたセラミックグリーンシート30を用い、その下側に図13（b）に示すように幅0．8mm及び＊長さ2．0mmの領域に導電ペーストを印刷して非接続型内部電極35を形成してなるセラミックグリーンシート36を積層した。そして、上下に適宜の枚数のセラミックグリーンシートを積層し、本発明品1と同様にして、本発明品2の積層サーミスタを作製した。

6

【0022】本発明品3…図14（a）に示すように、一方のセラミックグリーンシート37上に、幅0．8mm及び長さ1．0mmの第1，第2の分割電極38，39を本発明品1を得た場合と同様にして印刷した。セラミックグリーンシート37の下面に、図14（b）に示すセラミックグリーンシート33（図12（b）に示したものと同様に電極が形成されたもの）を積層し、その他の工程については本発明品1を得た場合と同様にして本発明品3の積層サーミスタを作製した。

【0023】本発明品4…本発明品2を得るのに用いたセラミックグリーンシート30，36（図13参照）を2組積層し、上下に適宜の枚数のセラミックグリーンシートを積層して全体の厚みを1．4mmとした成形体を得た。以後の工程については、本発明品1を得た場合と同様にして本発明品4の積層サーミスタを作製した。

【0024】従来品…従来品として、図15（a）に示すように、幅1．0mm、長さ1．9mmの大きさの領域に導電ペーストを塗布することにより電極40，41が形成されたセラミックグリーンシート42，43を積層し、上下に適宜の枚数のセラミックグリーンシートを積層して厚み1．4mmの積層体を得た。以後の工程については本発明品1を得た場合と同様にして従来品の積層サーミスタを作製した。上記のようにして作製された本発明品1～4及び従来品の積層サーミスタ各20個につき、25℃における抵抗値R_{25}及びB定数を測定した。結果をばらつき3CVとともに下記の表1に示す。

【0025】

【表1】

	R_{25} (Ω)	3CV (%)	B (K)	B3CV (%)
本発明品1	183	8．4	3053	0．20
本発明品2	260	5．0	3048	0．15
本発明品3	278	5．6	3062	0．18
本発明品4	91	6．0	3042	0．20
従　来　品	88	14．9	3031	0．21

【0026】表1から明らかなように、本発明品1～4では、抵抗値のばらつきが、8．4％以下と小さく、これに対して従来品では抵抗値のばらつきR_{3CV}が14．9％と非常に大きいことがわかる。なお、上述してきた実施例及び実験例では、焼結体全体がサーミスタとして機能する半導体磁器により構成されていたが、本発明の積層サーミスタにおいては、電極によって挟まれるセラミック層のみがサーミスタとして機能する材料で構成さ

7

れてさえおればよい。すなわち、電極間に挟まれるセラミック層以外のセラミック層についてはサーミスタとして機能しないセラミック材料により構成されていてもよい。

【0027】また、セラミック材料として、負特性を発揮し得るマンガンーニッケル系半導体磁器を用いたが、これに限るものではなく、他の負特性を発揮し得るセラミック材料を用いることができる。さらに、セラミック材料として、チタン酸バリウム系半導体磁器のようなサーミスタとして正特性を発揮し得る材料などを用いることもできる。

【0028】

【発明の効果】本願の第1発明では、内部電極の一方が第1，第2の分割電極により、他方が非接続型内部電極により構成されており、非接続型内部電極が第1，第2の分割電極の双方に重なり合わされているため、第1，第2の分割電極の形成位置及び／または非接続型内部電極の形成位置が若干ずれたとしても、内部電極間の重なり合い面積を一定に維持することができる。

【0029】また、第2発明では、第1，第2の分割電極の幅が、非接続型内部電極の幅と異ならされているため、狭い方の電極が、広い方の内部電極内に位置する限り、第1，第2の分割電極の形成位置及び／または非接続型内部電極の形成位置が焼結体の幅方向においてずれたとしても、内部電極間の重なり合い面積を一定に保つことが可能となる。よって、本願の第1，第2発明によれば、内部電極の重なり面積のばらつきを非常に小さくすることができるため、抵抗値のばらつきの少ない積層サーミスタを安定に供給することが可能となる。

【図面の簡単な説明】

【図1】第1の実施例の積層サーミスタの平面断面図。

【図2】従来例の積層サーミスタの縦断面図。

8

【図3】（a）及び（b）は、それぞれ、従来の積層サーミスタの内部電極形状を説明するための各平面図。

【図4】（a）及び（b）は、従来の積層サーミスタにおける電極の重なりずれが生じた場合の問題点を説明するための各平面図。

【図5】第1の実施例の積層サーミスタの斜視図。

【図6】第1の実施例の積層サーミスタの縦断面図。

【図7】第1の実施例の積層サーミスタを得る工程を説明するための分解斜視図。

【図8】第1の実施例の変形例を説明するための縦断面図。

【図9】第2の実施例の積層サーミスタの平面断面図。

【図10】第2の実施例の変形例を説明するための平面断面図。

【図11】（a）は、第3の実施例にかかる積層サーミスタの平面断面図、（b）は第3の実施例の変形例を説明するための平面断面図。

【図12】（a）及び（b）は、本発明品1における電極形状を説明するための各平面図。

【図13】（a）及び（b）は、本発明品2を得るのに用いられた電極形状を説明するための各平面図。

【図14】（a）及び（b）は、本発明品3を得るのに用いられた電極形状を説明するための各平面図。

【図15】（a）及び（b）は、従来品を得るのに用いられた電極形状を説明するための各平面図。

【符号の説明】

11…積層サーミスタ

12…焼結体

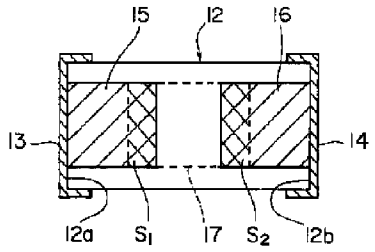
13，14…外部電極

15，16…第1，第2の分割電極

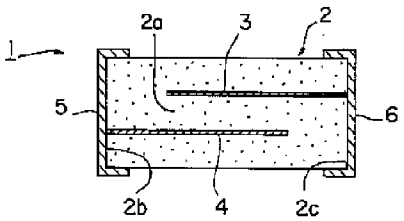
17…非接続型内部電極

12a，12b…端面

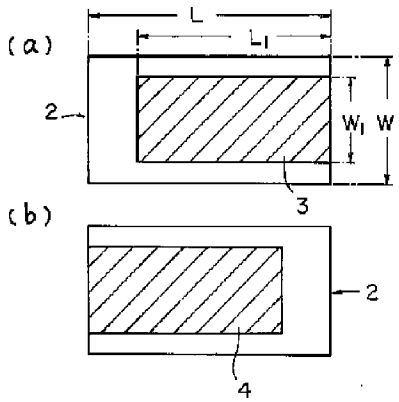
【図1】



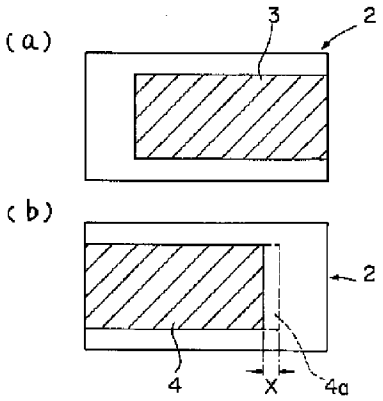
【図2】



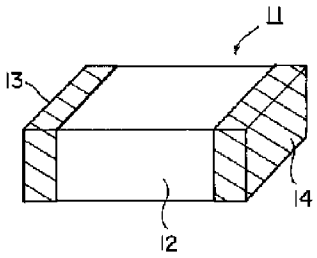
【図3】



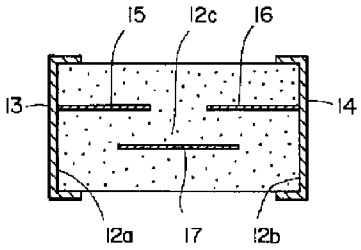
【図4】



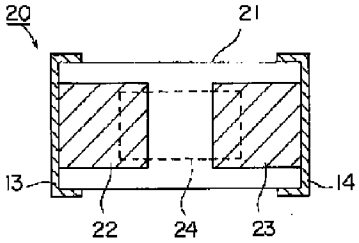
【図5】



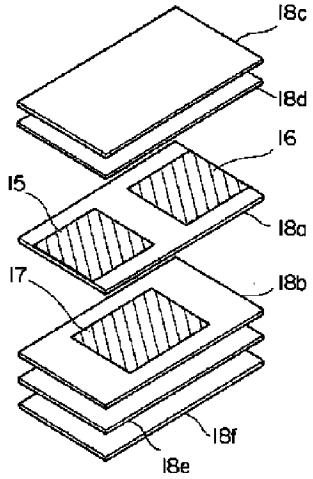
【図6】



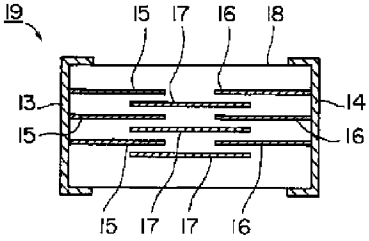
【図9】



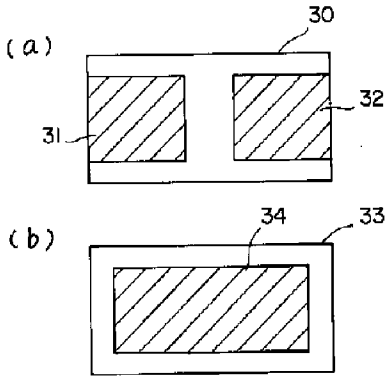
【図7】



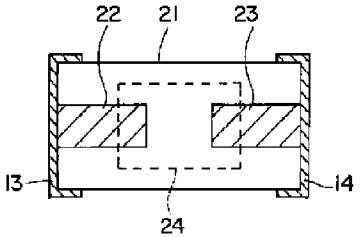
【図8】



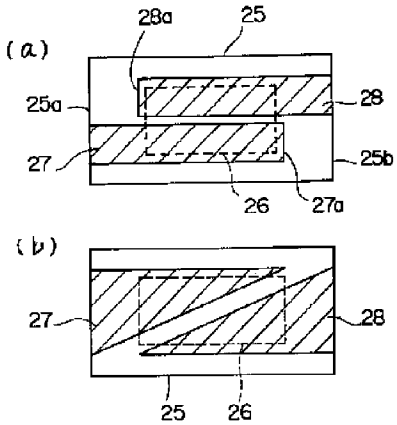
【図12】



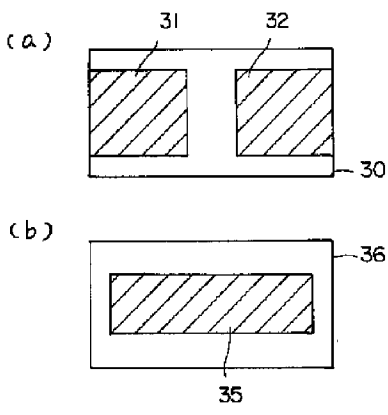
【図10】



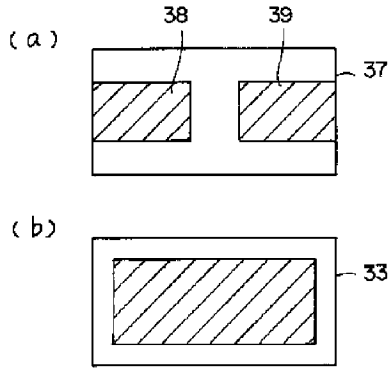
【図11】



【図13】



【図１４】



【図１５】